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METHOD FOR MANUFACTURING HEATING PAD USING ELECTRICALLY CONDUCTING POLYMER SUITABLE FOR USE IN MAINTAINING PATIENTS' BODY TEMPERATURE

TECHNICAL FIELD

The present invention relates to a method for manufacturing a heating pad suitable for use in maintaining patients'. body temperatures. More particularly, the present invention relates to the coating of an electrically conducting material, such as polypyrrole, polyaniline, or polythiophene, on a cloth in a chemical and an electrical polymerization process, so as to manufacture a heating pad which can safely maintain its temperature at at least at 40±5°C for 1-4 hours.

PRIOR ART

Since most of the hospital buildings that have recently been constructed or remodeled adopt centrally controlled heating and cooling systems, it is virtually impossible to regulate ward temperatures to accommodate every patient who is admitted to the hospitals. Thus, patients, who usually live in thin gowns for a long period of time in hospitals, are required to control and manage their own individual body temperatures. In particular, the patients who have just undergone surgical operations have difficulty in controlling their own body temperatures because of the stress and bleeding resulting from the operations and the exposure of internal organs to the outside for a' long period of time. In fact, since the interior temperatures of hospitals are usually maintained at 22-24 °C all the year round, the patients on whom operations have just been performed cannot recover their normal body temperature immediately so that they may suffer from shivering and hypoxia.

To prevent such problems which lead the patients to suffer serious consequences, a hypothermic control system or a warming air inflation blanket is typically employed for use in maintaining the body temperature of the patients

who have just undergone operations. Associated with a main body as large as an average washing machine, a hypothermic control system, in which warm water is circulated through a rubber mattress, is limitedly used. In addition, it is very expensive. As for the warming air inflation blanket, its function of warming patients is performed with warm air which is injected between double-sided covers. In addition to being expensive, this blanket, however, causes an environmental problem because it is disposable. Further, it is unpleasant to the touch because it is made of vinyl and non-woven fabrics. Swelling as warm air is injected, the blanket is inconvenient to cover patients with. Meanwhile, an electric blanket, which is extensively used for maintaining warmth, is prohibited from being used in hospitals because the electromagnetic waves generated during its operation may harm the patient and interfere with the operations of precision instruments in operating rooms, directly and indirectly. Furthermore, there is always the danger that the patient might receive an electric shock from the blanket because of the presence of water, such as physiological saline and blood, near the patient. Moreover, the patient may catch fire if the controller of the electric blanket is out of the order.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to overcome the above problems encountered in prior arts and to provide a method for manufacturing a heating pad which can safely generate heat by taking advantage of the heating properties of an electrically conducting polymer.

Based on the present invention, the above object could be accomplished by a provision of a method for manufacturing a heating pad using an electrically conducing polymer suitable for use in maintaining patients' body temperatures, comprising: a chemical polymerization process in which a cloth is treated with a solution containing dopants, distilled polymerizable monomers and an oxidizer at a high temperature under a high pressure to coat an electrically conducting polymer membrane onto the cloth, said cloth being composed of synthetic fibers such as

nylon or polyester, or a combination of synthetic fibers and natural fibers; an electrical polymerization process in which the cloth is washed with water to detach weakly bonded polymeric materials therefrom and covered with a magnetic patterning sheet such that a polymeric coating is allowed to grow thicker on the exposed areas of the cloth; and an instrumenting process in which a temperature sensor and controller and a portable power supply are provided to the cloth.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic view illustrating a high temperature and pressure system for use in the chemical polymerization of electrically conducting monomers in accordance with an embodiment of the present invention;

Fig. 2 is a schematic view illustrating a polymerization bath system for use in the electrical polymerization process in accordance with another embodiment of the present invention;

Fig. 3 is a side view showing a magnetic patterning sheet in accordance with a further embodiment of the present invention;

Fig. 4 is a schematic view illustrating a heating pad equipped with a temperature sensor and controller and a power supply;

Fig. 5 shows a temperature profile and a current profile of the heating pad, both of which are plotted with regard to time; and

Fig. 6 shows various applications of the heating pad.

BEST MODES FOR CARRYING OUT THE INVENTION

The present invention is essentially composed of a chemical polymerization process for coating an electrically conducting polymer membrane

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on a gray cloth and an electrical polymerization process for growing a polymer membrane with the aid of a magnetic patterning sheet.

In the chemical polymerization process, the electrically conducting polymer membrane is formed at about 50-150 °C under a pressure of 1-3 kgf/cm^2 by immersing a gray cloth in a bath containing dopants, polymerizable monomers, and an oxidizer. Suitable as the gray cloth is a synthetic fiber, such as a nylon fiber or a polyester fiber. In this process, an electrical current is passed through the cloth, so that it is used as an electrode in the electrical polymerization process.

The electrical polymerization process is conducted by applying the electrode with a current density of 1-9 mA/cm^2 while N_2 gas is bubbled for stirring in a polymerization bath.

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In order to provide the cloth with flexibility and an efficient heating structure, a pattern of a polymeric coating is formed on the cloth. In this regard, the cloth is covered with the magnetic patterning sheet such that a polymer is allow to grow thicker on the exposed areas of the cloth. Suitable for use as the polymeric material in the present invention are polypyrrole, polyaniline and polythiophene, all of which are electrically conductive. One or more of these electrically conductive polymers are coated by using a chemical and an electrical polymerization process in combination. A portable battery can be equipped on the heating pad to heat the heating pad to 40-45 °C. Also, a temperature sensor and controller is provided for controlling the temperature of the heating pad at below 45 °C because the skin is burned if it is exposed to higher 45 °C for 1 hour or longer. Thus, the heating pad can be used safely.

A better understanding of the present invention may be obtained in light of the following examples which are illustrated with referent to the accompanying drawings and set forth to illustrate, but are not to be construed to limit the present invention.

EXAMPLE 1

With reference to Fig. 1, there is a high-temperature, high-pressure system 3 in which chemical polymerization is conducted in accordance with an embodiment of the present invention. As illustrated in Fig. 1, a cloth 1, which is used as a substrate for the heating pad of the present invention, is repeatedly through a bath 2 containing dopants, distilled polymerizable monomers and an oxidizer while a chemical polymerization reaction occurs in the bath 2. To facilitate the chemical polymerization, the bath 2 is heated by a heater 4. During the chemical polymerization, the system 3 is maintained at about 50-150 °C under a pressure of 1-3 kgf/cm^2 for 3-100 min. The reason why such high temperature and pressure conditions are adopted is that, as in a dyeing process, the electrically conducting polymers obtained are forced to more actively impregnate into the cloth fibers under the high temperature and pressure conditions than under ordinary temperature and pressure conditions. Most of the polymers formed by the chemical polymerization stick to the cloth fibers via physical forces. After completion of the chemical polymerization, the cloth 1 is washed with water to detach the polymers which are weakly associated with the cloth 1. Afterward, the cloth is dried at room temperature or in an oven to give an electrically conducting polymer-impregnated cloth 1'.

EXAMPLE 2

With reference to Fig. 2, a polymerization bath system is provided for electrical polymerization according to another embodiment of the present invention. In the polymerization bath system, the cloth 1', which is obtained in Example 1, is allowed to undergo electrical polymerization. In this regard, the working electrode is applied with a current density of 1-9 mA/cm^2 while the bath is bubbled from its bottom with N_2 gas for stirring. The cloth is subjected to patterning with the aid of a magnet to increase the amount of electrically conducting polymeric materials which are coated onto the cloth and to improve the quality of the coating. To achieve a preferred patterning result, the rotating speed of rollers 5 may be adjusted. Because the ions present in the polymerization bath

are positively charged, when an N pole, which is cathode, faces to an opposing electrode 7, the cations in the polymerization bath are attracted toward the working electrode under the influence of the magnetic field formed, such that the cations coat onto the cloth which closely contacts the working electrode. As a result, the cloth is found to be improved in surface morphology as observed with a microscope. In addition, the cloth 1' is has a surface resistance of approximately 10 Ω/□ which is lower than that of the cloth which is obtained by electrical polymerization using a patterning sheet.

EXAMPLE 3

Referring to Fig. 3, there is shown a patterning sheet 6 in a side view, with which a pattern is formed on the cloth upon the electrical polymerization, in accordance with another embodiment of the present invention. The patterning is for the purpose of providing the cloth with flexibility. In this connection, a magnetic patterning sheet like that shown in Fig. 3 is covered over the cloth so that a polymeric coating is allowed to grow thicker on the exposed areas of the cloth. Thus, the rollers are quickly rotated whenever the cloth passes through patterning parts 9. Once the passing of the cloth is completed, electrical polymerization is achieved, giving a pattern after the patterning sheet 6. Because a larger number of cations of the polymerization bath are attracted toward the N poles which are negatively charged, a larger amount of electrically conducting polymer materials are coated on the areas near the N poles.

EXAMPLE 4

With reference to Fig. 4, there is a heating pad 13 equipped with a temperature sensor, a temperature controller and a power supply 8, which is manufactured in accordance with the present invention. When prepared only through chemical polymerization, the cloth is found to range in resistance from approximately 10^0 to 10^2 KΩ/□. However, the coated areas of the cloth which are

patterned with the aid of the patterning sheet are measured to have a resistance of approximately 10^{-2} to 10^{2} $\Omega/\square$. Therefore, electrical paths on the heating pad are formed along the trace of the patterned parts 10 which are used for the electrical polymerization. Complying with the Joule heating, the calorific power of the heating pad is represented by the following formula: $Q = 0.24\ I^2 Rt$ (cal). Depending on the materials, the temperature of the heating pad increases according to the following formula: $Q=C_m m\ \Delta T$ wherein C_m represents heat capacity and m represents a mass.

EXAMPLE 5

With reference to Fig. 5, there is a temperature profile of a heating pad manufactured in accordance with the present invention, which is plotted with regard to a period of time, along with a current profile provided to the heating pad. To obtain the temperature profile, a 12 V lithium ion battery was mounted on the heating pad which was then tested for heating. As shown in the temperature profile, the heating pad is heated to above 40 °C shortly after the supply of power from the battery and is maintained at more than 40 °C for 8 hours or longer.

INDUSTRIAL APPLICABILITY

As described hereinbefore, a heating pad can be manufactured by coating a cloth with an electrically conducting polymeric material which generates no generating electromagnetic wavelengths harmful to the body in a combination of a chemical and an electrical polymerization process. To the heating pad, a portable power supply is provided for generating heat and a temperature sensor and controller for controlling the temperature.

Although the heating pad of the present invention has been descried for use in maintaining patients' body temperatures, it will be understood that the teachings herein can be applied to various products as well, including grooves, dresses, shoes, tents, etc., as shown in Fig. 6.

While the foregoing examples illustrate and describe the use of the present invention, they are not intended to limit the present invention as disclosed in certain preferred embodiments herein. Therefore, variations and modifications commensurate with the above teachings and the skill and/or knowledge of the relevant are, are within the scope of the present invention.